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Tutorial

Efficient Stochastic-deterministic Dosimetry Procedures for exposures to mm Waves range for 5G systems

Organizers:

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Abstract

Human exposure to mobile communications systems of fifth generation (5G) may result in a local temperature increase at the body surface (skin, ear and eye in particular). According to ICNIRP 2020 guidelines, this surface heating is quantified by absorbed power density (Sab) above transition frequency of 6GHz, while for the frequencies below 6GHz well-known quantity specific absorption rate (SAR) is used. Also, transmitted power density (TPD), an alternative dosimetric quantity and metric providing an estimation of skin temperature elevation for human exposure to EM fields at GHz frequency range is used.

The presentation first starts with simple incident dosimetry procedures to estimate the field radiated by 5G systems. This is followed by deterministic internal dosimetry procedures. As an opener to the subject, an analytical assessment of Sab and TPD for the case of Hertz dipole radiating in the presence of a lossy half-space will presented. It will be followed by an analytical/numerical assessment of Sab in the homogeneous planar model of the human tissue due to radiation of horizontal

dipole antenna of finite length in GHz frequency range. Next topic of interest is the calculation of incident power density (IPD) and related temperature increase in multilayer tissue model using different numerical methods based on the paper prepared by IEEE ICES working group and recently published in IEEE Access (November 2021 Issue).

The last part of the Tutorial will deal with stochastic-deterministic electromagnetic-thermal dosimetry in lower portion of GHz frequency range. Starting with an overview of some of the most relevant stochastic modelling techniques in bioelectromagnetism, the presentation continues with a more detailed description of the stochastic collocation method. What follows afterwards are several examples of stochastic collocation method application, particularly for analysis of anatomically based realistic multi-layered model of the human head exposed to radiation from 5G communication systems. This part of the talk is based on the recently published paper in IEEE TEMC Special Issue on Progress in Environmental Electromagnetic Safety and Biomedical EMC (October 2021 Issue).

Some concluding remarks and future work directions, primarily based on IEEE ICES WG 7, will be outlined.

ABOUT THE ORGANIZERS

Dragan Poljak received his PhD in el. Eng. in 1996 from the Univ. of Split, Croatia. He is the Full Prof. at Dept. of Electron. and Computing, Univ. of Split. His research interests include computational electromagnetics (electromagnetic compatibility, bioelectromagnetics, ground penetrating radar and plasma physics). To date Prof. Poljak has published more than 160 journ. and 250 conf. papers, and authored some books, e.g. two by Wiley, New Jersey and one by Elsevier, St Louis. He is a Senior member of IEEE, a member of Editorial Board of Eng. Anal. with Boundary Elements, Math. Problems in Eng. And IET Sci. Measur. & Techn. He was awarded by several prizes for his research achievements, such as National Prize for Science (2004), Croatian sect. of IEEE annual Award (2016), Technical Achievement Award of the IEEE EMC Society (2019) and George Green Medal from University of Mississippi (2021). From May 2013 to June 2021 Prof. Poljak was a member of the board of the Croatian Science Foundation. He was involved in ITER physics EUROfusion collaboration and he is currently involved in DONES EUROfusion collaboration and in Croatian center for excellence in research for tech. sciences. He is active in few Working Groups of IEEE/Internat. Committee on Electromagnetic Safety (ICES) Tech. Comm. 95 SC6 EMF Dosimetry Modeling.

Anna Šušnjara received her Ph.D degree in 2021 from the Univ. of Split, Croatia. She currently works as a postdoc researcher at FESB, Univ. of Split. Her research interests include numerical modelling, uncertainty quantification and sensitivity analysis in computational electromagnetics. In 2016 dr. Šušnjara received the best poster award at BioEM conference in Ghent and spent one month at Politecnico di Torino as ACRI YITP awardee. In 2018 she held “Intensive seminar on numerical analysis for engineers” at Malardalen University, Vasteras, Sweden and a lecture on numerical modelling for ground penetrating radar simulations at “Training School on Ground Penetrating Radar for civil engineering and cultural heritage management” at Sapienza University in Rome. In 2019 dr. Šušnjara gave a tutorial at SpliTECH conference entitled “Interaction of humans with electromagnetic fields”. From 2015 until 2021 dr. Šušnjara was a member WPCD while in 2021 she joined WPENS work group, both under EUROfusion project. In the period 2018-2020 she participated in a Slovenian-Croatian project “Development of an algorithm for a coupled simulation of flow and bioelectromagnetics”. Dr. Šušnjara is a member of IEEE and EBEA societies. She currently serves as a Vice President of Croatian chapter of IEEE EMC society. To date, dr. Anna Šušnjara authored and co-authored 14 journal and more than 30 conference papers as well as one book chapter for Springer series on Uncertainty Modelling for Engineering Applications. She serves as a reviewer to seven journals. A complete list of her publications can be found at: https://www.bib.irb.hr/pregled/znanstvenici/348056.

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